

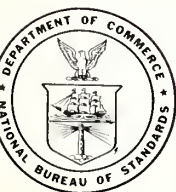
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Central Radio Propagation Laboratory

IONOSPHERIC PREDICTIONS

*for
August
1963*

TB 11-499-5/TO 31-3-28



U.S. DEPARTMENT of COMMERCE
National Bureau of Standards
Number 5/Issued May 1963

U.S. DEPARTMENT OF COMMERCE
Luther H. Hodges, Secretary



NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

Central Radio Propagation Laboratory
Ionospheric Predictions
for August 1963

Number 5

Issued

May 1963

[Formerly "Basic Radio Propagation Predictions," CRPL Series D.]

The CRPL Ionospheric Predictions are issued monthly as an aid in determining the best sky-wave frequencies over any transmission path, at any time of day, for average conditions for the month. Issued three months in advance, each issue provides tables

of numerical coefficients that define the functions describing the predicted worldwide distribution of f_oF_2 and $M(3000)F_2$ and maps for each even hour of universal time of $MUF(Zero)F_2$ and $MUF(4000)F_2$.

NOTE: Department of Defense personnel see back cover.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget (June 19, 1961).

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price 15 cents.

Annual subscription (12 issues) \$1.50 (50 cents additional for foreign mailing).

National Bureau of Standards

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and tech-

nical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. The Bureau also serves as the Federal technical research center in a number of specialized fields.

Central Radio Propagation Laboratory

The Central Radio Propagation Laboratory at Boulder, Colorado, is the central agency of the Federal Government for the collection, analysis, and dissemination of information on propagation of radio waves at all frequencies along the surface of the earth, in the atmosphere, and in space, and performs scientific studies looking toward new techniques for the efficient use and conservation of the radio spectrum. To carry out this responsibility, the CRPL—

1. Acts as the central agency for the conduct of basic research on the nature of radio waves, the pertinent properties of the media through which radio waves are transmitted, the interaction of radio waves with those media, and on the nature of radio noise and interference effects. This includes compilation of reports by other foreign and domestic agencies conducting research in this field and furnishing advice to government and nongovernment groups conducting propagation research.

2. Performs studies of specific radio propagation mechanisms and performs scientific studies looking

toward the development of techniques for efficient use and conservation of the radiofrequency spectrum as part of its regular program or as requested by other government agencies. In an advisory capacity, coordinates studies in this area undertaken by other government agencies.

3. Furnishes advisory and consultative service on radio wave propagation, on radiofrequency utilization, and on radio systems problems to other organizations within the United States, public and private.

4. Prepares and issues predictions of radio wave propagation and noise conditions and warnings of disturbances in these conditions.

5. Acts as a central repository for data, reports, and information in the field of radio wave propagation.

6. Performs scientific liaison and exchanges data and information with other countries to advance knowledge of radio wave propagation and interference phenomena and spectrum conservation techniques, including that liaison required by international responsibilities and agreements.

Introduction

The "Central Radio Propagation Laboratory Ionospheric Predictions" is the successor to the former "Basic Radio Propagation Predictions," CRPL Series D. To make effective use of these predictions, National Bureau of Standards Handbook 90, "Handbook for CRPL Ionospheric Predictions Based on Numerical Methods of Mapping," should be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., price 40 cents. This Handbook includes required additional data, nomographs and graphical aids, as well as methods for the use of the predictions. The Handbook supersedes the obsolete NBS Circular 465.

The basic prediction appears in tables 1 and 2, presenting predicted coefficients for foF2 and M(3000)F2 defining the numerical map functions describing the predicted worldwide variation of these characteristics. With additional auxiliary information, these coefficients may be used as input data for electronic computer programs solving specific high frequency propagation problems. The basic equations, their interpretation, and methods of using the numerical maps are described in two papers by W. B. Jones and R. M. Gallet, "The Representation of Diurnal and Geographic Variation of Ionospheric Data by Numerical Methods," Volume 66D, Number 4, July-August 1962, pages 419-438, and "Methods for Applying Numerical Maps of Ionospheric Characteristics," Volume 66D, Number 6, November-December 1962, pages 649-662, both in the Journal of Research of the National Bureau of Standards, Section D. Radio Propagation. The predicted numerical map coefficients of tables 1 and 2 may be purchased in the form of a tested set of punched cards. Write to the Prediction Service Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado, to arrange for the purchase of the set of punched cards and for further information and assistance in the application of computer methods and numerical prediction maps to specific propagation problems.

The graphical prediction maps, derived from the basic prediction, are provided for those unable to make use of an electronic computer. Figures 1 to 12 present world maps of MUF(Zero) F2 and MUF(4000)F2 for each even hour of universal time. Figures 13 to 16 present the same predictions for hours 00 and 12 universal time for the North and South Polar areas. Predicted polar maps for each even hour of universal time may be obtained by special arrangements with the Central Radio Propagation Laboratory. Handbook 90 describes methods for including regular E-F1 propagation. Figure A is a graph of predicted and observed Zürich sunspot numbers which shows the recent trend of solar activity. Table A lists observed and predicted Zürich smoothed relative sunspot numbers and includes the sunspot number used for the current prediction.

Members of the U.S. Army, Navy, or Air Force desiring the Handbook and the Ionospheric Predictions should send requests to the proper service address; for the Navy: The Director, Naval Communications, Department of the Navy, Washington 25, D.C.; for the Air Force: Directorate of Command Control and Communications, Headquarters, United States Air Force, Washington 25, D.C., Attention: AFOCCAA. Army personnel should refer to the Handbook as TM 11-499 and to the monthly predictions as TB 11-499-(), predictions for the month of August 1963 being distributed in May 1963 and designated TB 11-499-(5), and should requisition these through normal publication channels.

Information concerning the theory of radio wave propagation and such important problems as absorption, field intensity, lowest useful high frequencies, etc., is given in National Bureau of Standards Circular 462, "Ionospheric Radio Propagation." This may be obtained from the Superintendent of Documents, price \$1.25 (to foreign countries, \$1.65). A revised work is in preparation which will be announced in the Ionospheric Prediction series when available. Additional information about radio noise may be found in C.C.I.R. Report Number 65, "Revision of Atmospheric Noise Data," International Telecommunication Union, Geneva, 1957.

Reports to this Laboratory of experience with these predictions would be appreciated. Correspondence should be addressed to the Predictions Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado.

Table A

Observed and Predicted Zurich Smoothed Relative
Sunspot Numbers

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1952	43 (53)	42 (51)	39 (52)	36 (52)	34 (52)	32 (52)	31 (51)	29 (49)	28 (46)	28 (43)	27 (38)	26 (33)
1953	24 (30)	22 (29)	20 (27)	19 (24)	17 (22)	15 (21)	13 (20)	12 (18)	11 (18)	10 (17)	9 (16)	7 (15)
1954	6 (14)	6 (12)	4 (11)	3 (10)	4 (10)	4 (9)	5 (8)	7 (8)	8 (8)	8 (10)	10 (10)	12 (11)
1955	14 (12)	16 (14)	20 (14)	23 (13)	29 (16)	35 (18)	40 (22)	46 (27)	55 (30)	64 (31)	73 (35)	81 (42)
1956	89 (48)	98 (53)	109 (60)	119 (68)	127 (77)	137 (89)	146 (95)	150 (105)	151 (119)	156 (135)	160 (147)	164 (150)
1957	170 (150)	172 (150)	174 (150)	181 (150)	186 (150)	188 (150)	191 (150)	194 (150)	197 (150)	200 (150)	201 (150)	200 (150)
1958	199 (150)	201 (150)	201 (150)	197 (150)	191 (150)	187 (150)	185 (150)	185 (150)	184 (150)	182 (150)	181 (150)	180 (150)
1959	179 (150)	177 (150)	174 (150)	169 (150)	165 (146)	161 (143)	156 (141)	151 (142)	146 (141)	141 (139)	137 (137)	132 (137)
1960	129 (136)	125 (135)	122 (133)	120 (130)	117 (125)	114 (120)	109 (118)	102 (115)	98 (110)	93 (108)	88 (105)	84 (100)
1961	80 (100)	75 (90)	69 (90)	64 (90)	60 (85)	56 (85)	53 (80)	52 (75)	52 (70)	51 (70)	50 (65)	48 (60)
1962	44 (60)	41 (50)	39 (48)	38 (45)	38 (42)	37 (37)	36 (34)	34 (31)	(29)	(28)	(27)	(34)
1963	(31)	(28)	(26)	(25)	(25)	(25)	(23)	(21)*				

Note: Final numbers are listed through June 1961, the succeeding values being based on provisional data. The predicted numbers are in parentheses.

* Number used for predictions in this issue.

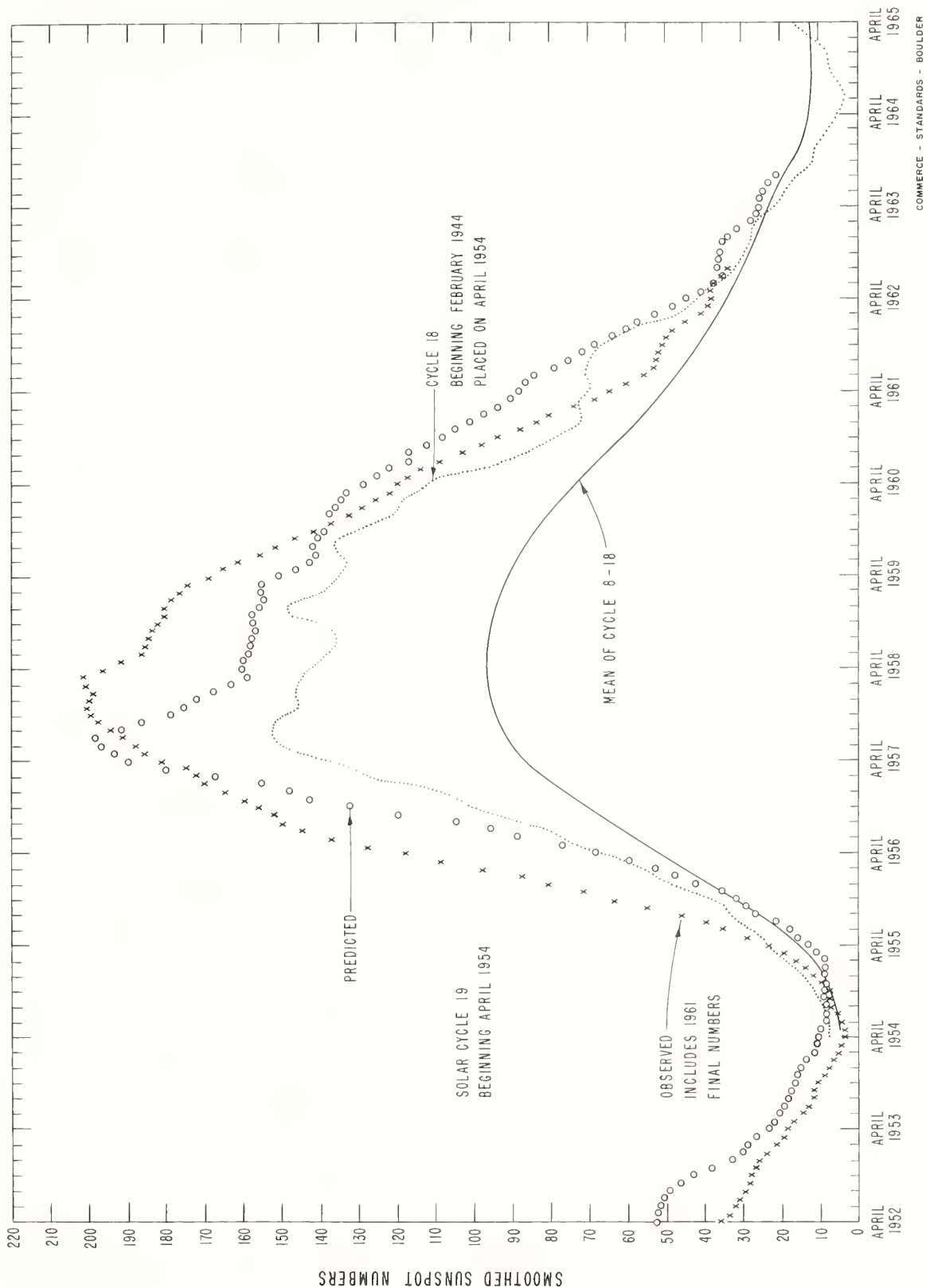


FIG. A. PREDICTED AND OBSERVED SUNSPOT NUMBERS

TABLE I

TIME VARIATION[illegible]

Harmonic		5		6		7		8	
	K	9	10	11	12	13	14	15	16
I	0	0.9795492E-02	1.5824689E-01	-1.2707377E-01	1.9363551E-02	-3.8796354E-02	-7.4262659E-02	0.2700983E-02	-1.6697361E-02
	1	-0.523350E-01	-4.304942E-01	2.7893134E-01	-8.5416161E-02	1.3867044E-01	3.3738475E-03	0.7642644E-03	5.001501E-02
	2	-0.523716E-01	-5.007357E-01	3.7389433E-01	-7.8680031E-02	4.6173697E-02	1.3022710E-01	-0.5236652E-01	5.011110E-02
	3	-0.523716E-01	-5.007357E-01	3.7389433E-01	-7.8680031E-02	4.6173697E-02	1.3022710E-01	-0.5236652E-01	5.011110E-02
	4	0.1617437E-01	1.3706992E-01	-0.2926060E-01	0.0507031E-02	-1.44989971E-01	-1.2939498E-03	-0.177891E-03	-5.1367138E-02
							-7.3568777E-02	0.354502E-02	6.807353E-02

I - Main latitudinal variation. Mixed latitudinal and longitudinal variation; II - First order in longitude, III - Second order in longitude
 Notation: For each entry the number given by the first eight digits and sign is multiplied by the power of ten defined by the last two digits and sign.

PREDICTED COEFFICIENTS D_{sk} DEFINING THE FUNCTION $\Gamma(\lambda, \theta, t)$ FOR MONTHLY MEDIAN t_0 F2 (Mc/s)
AUGUST 1963

TABLE 2

TABLE 2

TIME VARIATION

Harmonic	O	I	2	3	4	5	3
K	S	I	2	3	4	5	3
I	0	-1.1398313E-01	-2.4677827E-01	-2.5914230E-02	-8.2017460E-02	1.2761201E-02	-1.8769956E-02
1	0	-8.5041152E-02	-1.2880360E-01	1.0727159E-01	-1.2075907E-01	7.7203950E-02	7.7203950E-02
2	1	5.5936612E-01	1.9869744E 00	1.5299525E-01	-5.6975670E-01	-3.4277865E-01	-3.4277865E-01
3	1	3.6163362E-01	5.4199459E-01	-8.2325969E-01	3.9613392E 00	-3.0518638E-01	-3.0518638E-01
4	1	-9.3243377E-01	-0.0997688E 00	-1.1509982E 00	2.3159334E 00	1.3354762E 00	2.1663403E-02
5	2	-3.7834111E-01	-1.1204950E 00	1.5511483E 00	-0.5759467E 00	4.6754865E-01	6.4489268E-01
6	2	7.4460924E-01	3.8638693E 00	2.1240439E 00	-8.8337615E 00	-1.8768341E 00	3.6367236E-01
7	1	1.2238154E-01	6.9911476E-01	-8.5125519E-01	3.3459323E 00	-2.3694214E-01	-3.6383035E-01
8	1	-2.05959704E-01	-1.5867434E 00	-1.1118335E 00	1.1836426E 00	8.7401513E-01	-2.9199750E-01
II	9	-3.2660100E-04	2.9501283E-02	-3.6380352E-02	5.6688883E-03	1.7498608E-02	-5.5975045E-03
10	6.4622458E-03	9.9171718E-03	1.9222119E-02	-2.9717892E-02	2.7148930E-02	6.0286496E-03	1.7707619E-02
11	3.1022405E-02	6.8517250E-02	1.8422384E-01	4.9584265E-02	7.0793412E-03	-4.0281535E-02	-4.1921884E-02
12	-1.984972E-01	-2.5386339E-01	-9.801378E-01	7.0437645E-02	-7.0873360E-02	1.0380103E-01	1.5609438E-01
13	7.8797960E-02	1.5936844E-01	-5.7603933E-01	4.5256441E-01	-2.7116034E-01	-1.6728121E-01	-1.0784161E-01
14	3.3885398E-02	5.1705889E-01	-1.3054020E-01	3.7374508E-01	-5.8401820E-01	-2.5435260E-02	-1.2328261E-01
15	-1.4406307E-01	3.6030910E-01	-7.4625899E-01	-3.46404357E-01	1.9842456E-01	1.0487048E-01	2.5998686E-01
16	1.2538305E 00	1.4493890E 00	3.0920210E 00	-8.1094590E-01	3.4790273E 00	-8.2856923E-01	-9.3401370E-01
17	-0.0666807E-01	1.5199780E 00	2.0225411E 00	-1.7354266E 00	2.7179015E 00	5.5337180E-01	5.7603173E-01
18	-1.2939395E-01	3.1509540E 00	2.2833083E-01	6.5795559E-02	-5.5912014E-01	-9.4435089E-02	9.0688461E-02
19	3.0321483E-01	-8.5227319E-01	8.5406593E-01	2.1327757E 00	-5.2366670E-01	2.0171933E-01	-4.2828799E-01
20	-4.4316735E 00	-2.7918245E 00	-9.9240199E 00	2.5687115E 00	-1.6842609E 00	1.6676652E 00	1.6062956E 00
21	5.2035374E-01	-3.7134824E 00	-0.0884710E 00	2.8609926E 00	-1.1440907E 00	-1.384664E-01	-5.3446289E-01
22	1.0081330E-01	-6.0470694E 00	1.9199355E-02	-3.9558807E-01	3.8760974E-01	2.3555868E-01	9.1345469E-02
23	-4.9298393E-01	4.9608839E-01	-7.5304593E-02	1.5511710E 00	2.7527675E-01	-9.7097112E-01	-8.5739940E-01
24	3.2106931E-01	1.7501234E 00	2.6491401E 00	-1.0743584E 00	9.4414783E-01	-5.2346190E-02	-1.8218458E-02
25	-3.2118762E-01	2.5883849E 00	8.4706221E-01	-1.44597565E 00	2.0098923E 00	-1.2114018E-01	-9.0064631E-02
26	-4.3562299E-02	3.5915726E 00	-3.5211595E-01				
III	27	2.0524917E-03	1.9085599E-03	5.2479894E-02	-3.0252470E-02	-7.5910261E-04	-9.1001788E-04
28	-3.1730036E-04	-1.0812803E-02	1.7689586E-02	-1.0995986E-02	9.8011466E-03	1.666560E-03	1.666560E-03
29	-2.7835145E-03	-9.6487385E-02	9.7584989E-03	-1.8278786E-04	-2.1400328E-03	-1.4180839E-03	-1.4180839E-03
30	-1.0426115E-03	-2.9994820E-02	-5.3194284E-02	3.7786935E-02	-4.0049670E-04	2.7830046E-04	2.7830046E-04
31	-1.0852856E-02	-1.4103344E-02	-1.0502422E-01	1.8503116E-01	7.3908247E-04	3.4495834E-03	3.4495834E-03
32		1.2530273E-01	-1.2137295E-01	4.4068683E-02	2.5494665E-03		
33		2.1840864E-01	4.4030725E-03	-4.2182582E-02	6.9509040E-03		
34		1.8795305E-01	1.0298867E-03	-6.0017978E-03			
35			2.5630592E-02	-2.8327309E-01			
36							

GEOGRAPHICAL VARIATION

Harmonic	4	5	6		
	7	9	11		
K	8	10	12		
I	0	4.9605934E-03	2.8958185E-02	-1.1533006E-02	2.9648924E-03
	1	3.5651840E-02	-3.4012638E-02	-1.6454309E-02	4.8558965E-03
	2	3.0685808E-03	7.7949167E-04	-3.8249108E-02	1.5184649E-02
	3	-5.0096006E-02	2.5399355E-02	1.5078945E-02	1.5803559E-02
		-1.9818753E-02			

I - Main latitudinal variation Mixed latitudinal and longitudinal variation: II - First order in longitude, III - Second order in longitude.

Notation: For each entry the number given by the first eight digits and sign is multiplied by the power of ten defined by the last two digits and sign.

PREDICTED COEFFICIENTS D_{SK} DEFINING THE FUNCTION $\Gamma(\lambda, \theta, t)$ FOR MONTHLY MEDIAN $M(3000)F2$

AUGUST 1963

AUGUST 1963 UT = 00

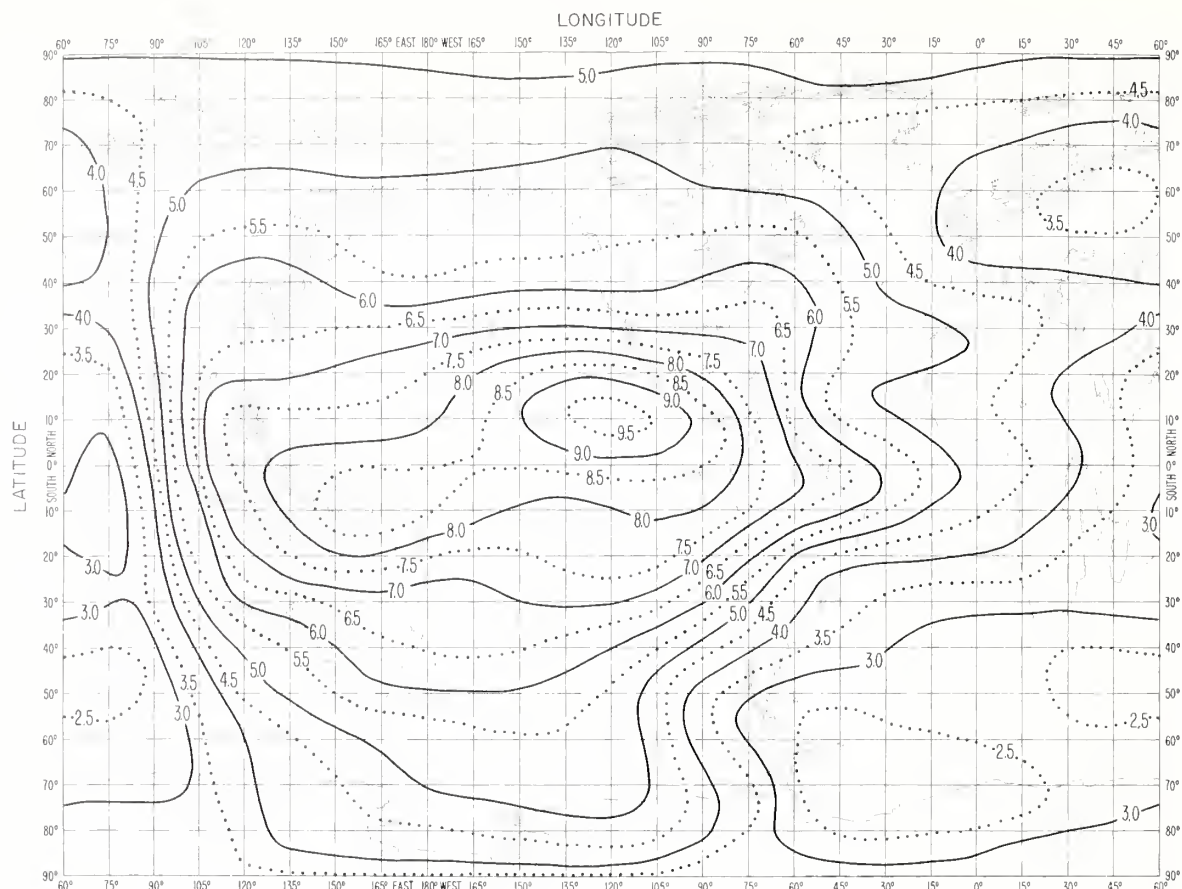


FIG 1A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

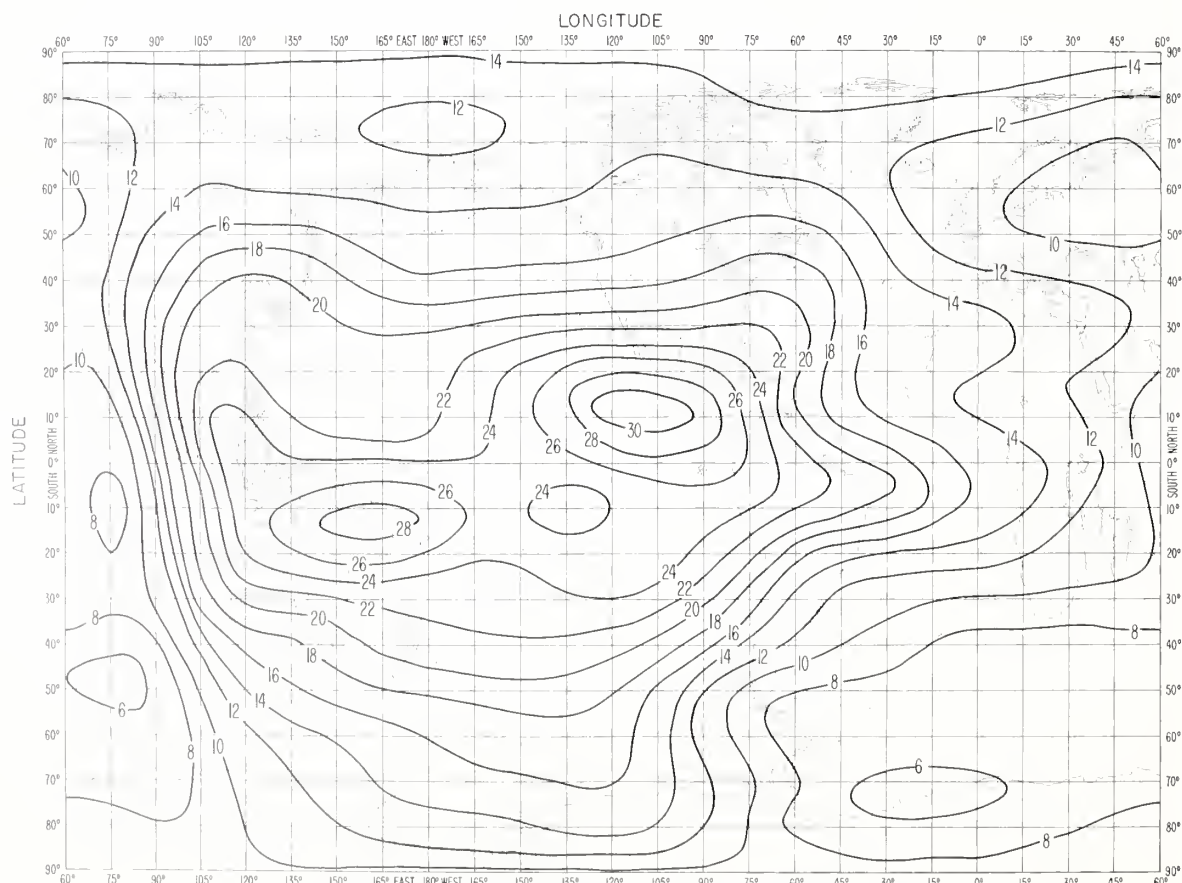


FIG 1B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1963 UT = 02

LONGITUDE

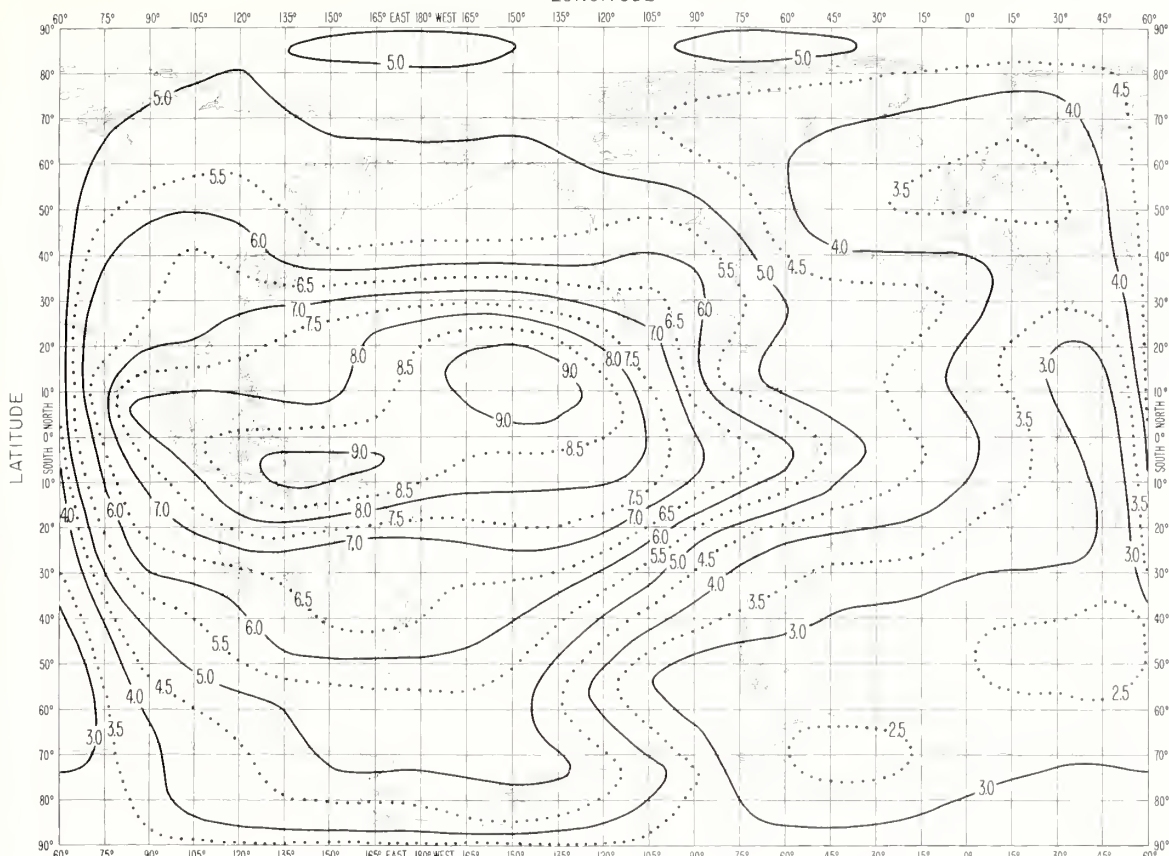


FIG 2A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

LONGITUDE

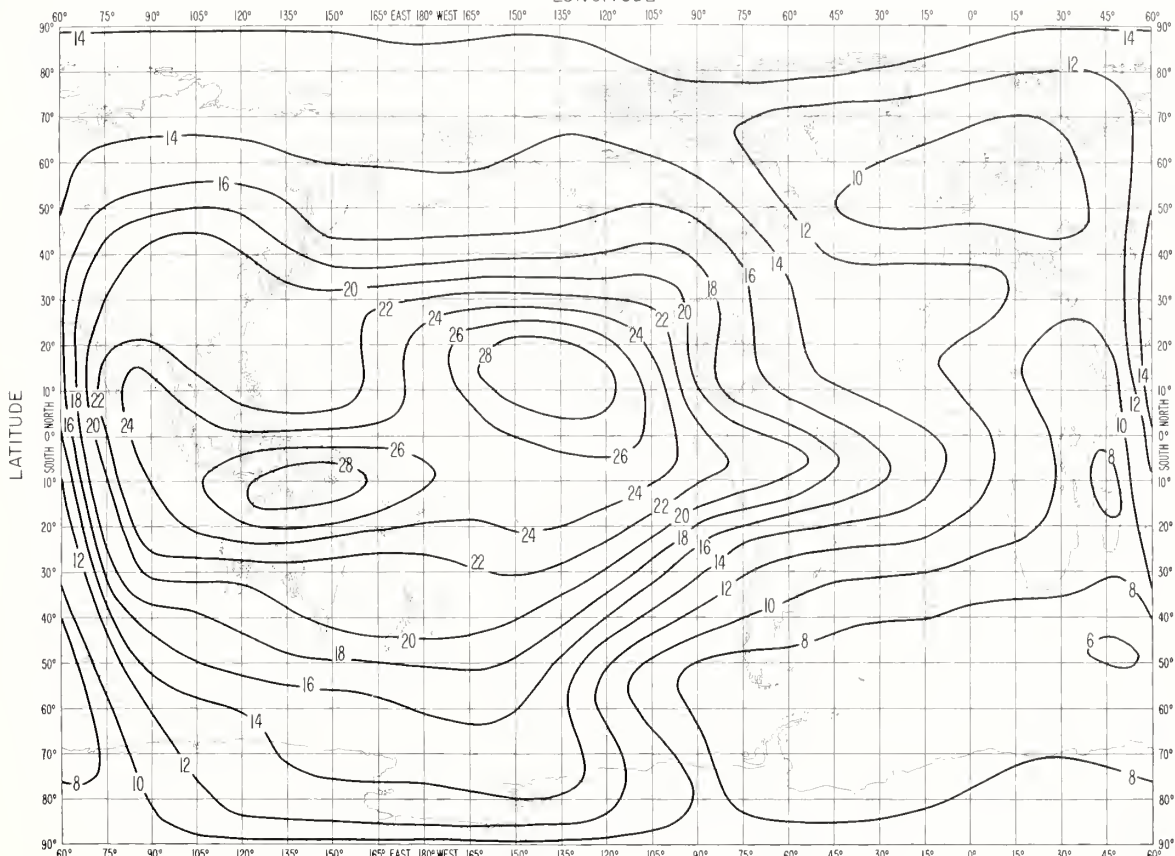


FIG. 2B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1963 UT = 04

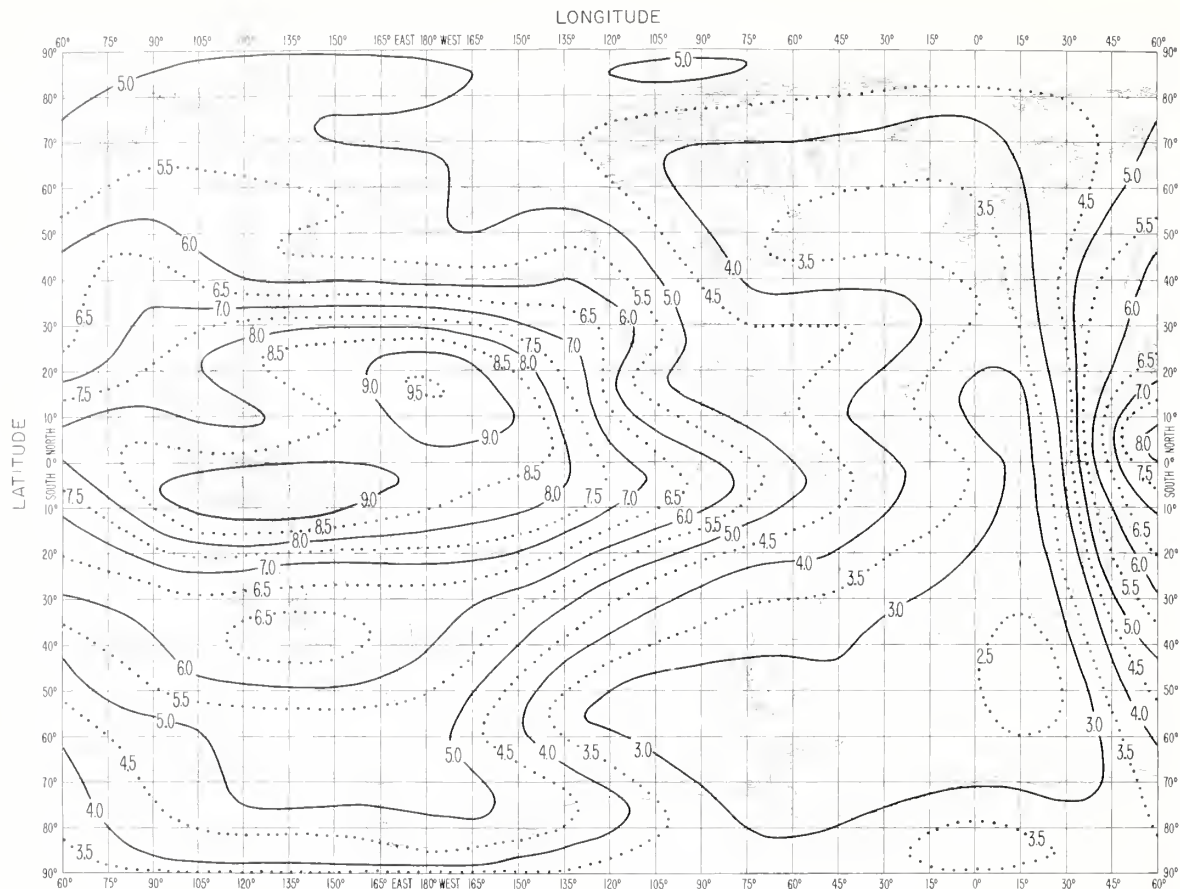


FIG. 3A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

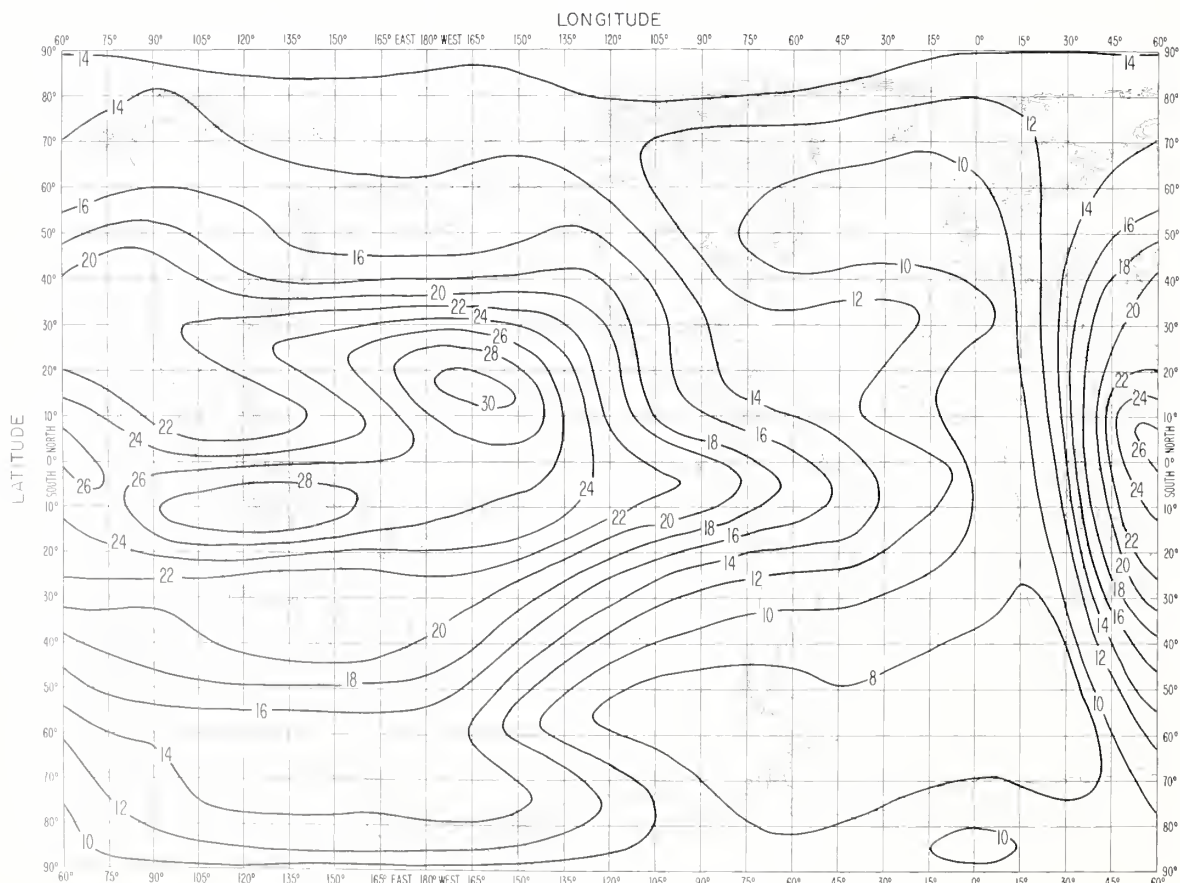


FIG. 3B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1963 UT = 06

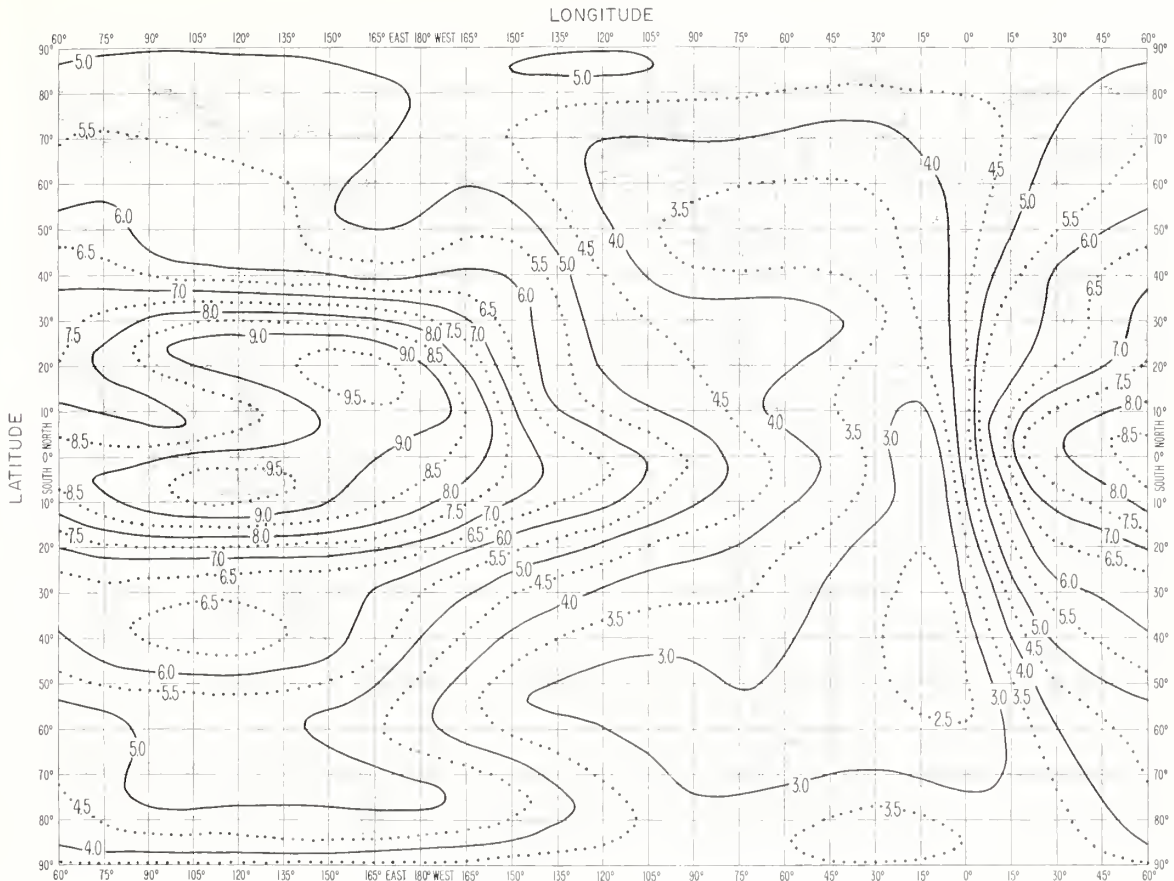


FIG 4A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

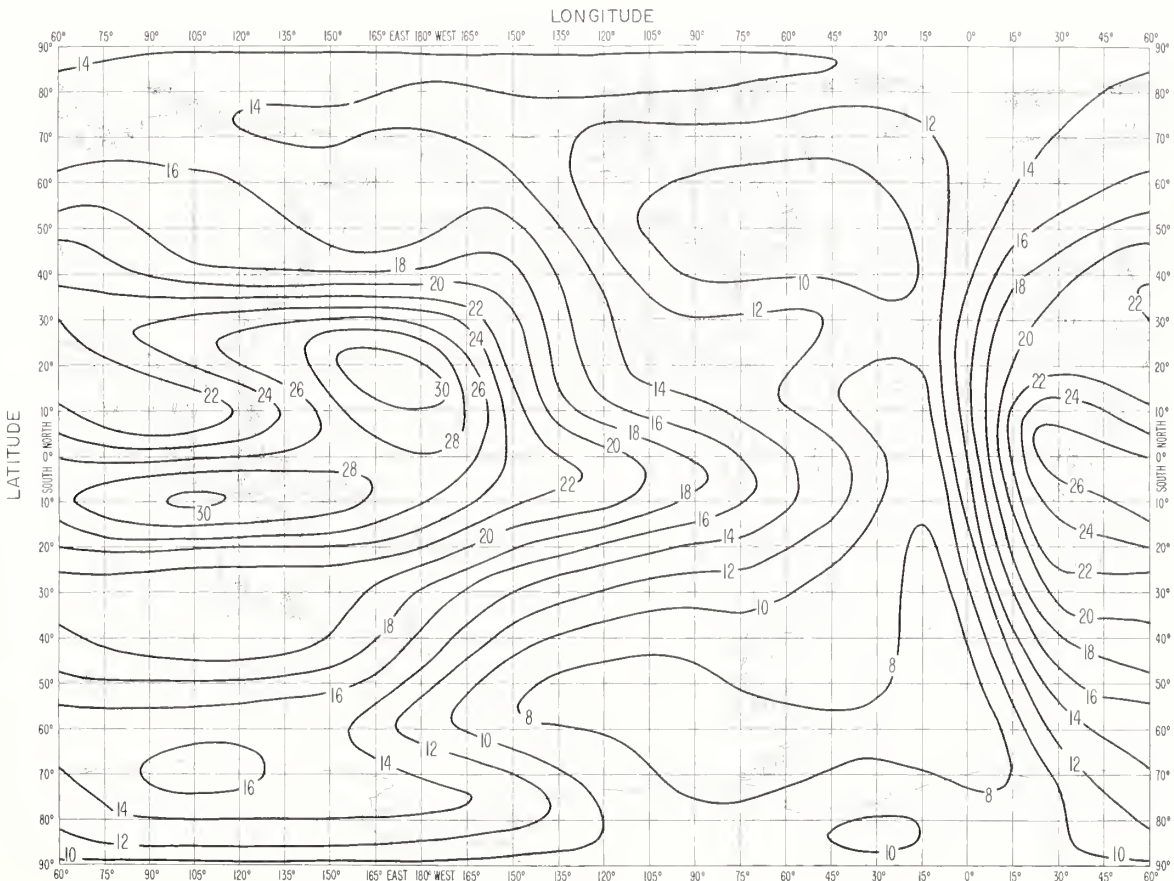


FIG 4B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

UT = 08

LONGITUDE



FIG 5A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)



FIG. 5B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1963 UT=10

LONGITUDE



FIG 6A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

LONGITUDE

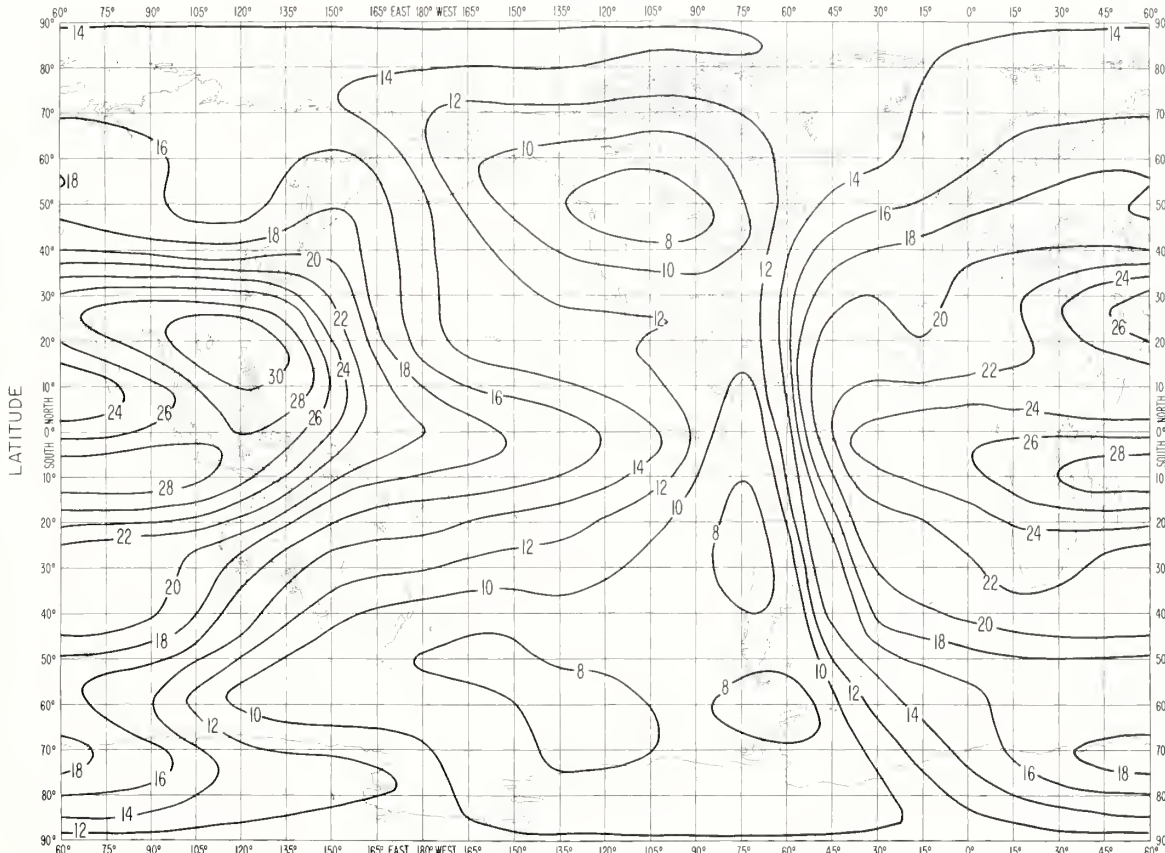


FIG 6B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1963 UT = 12

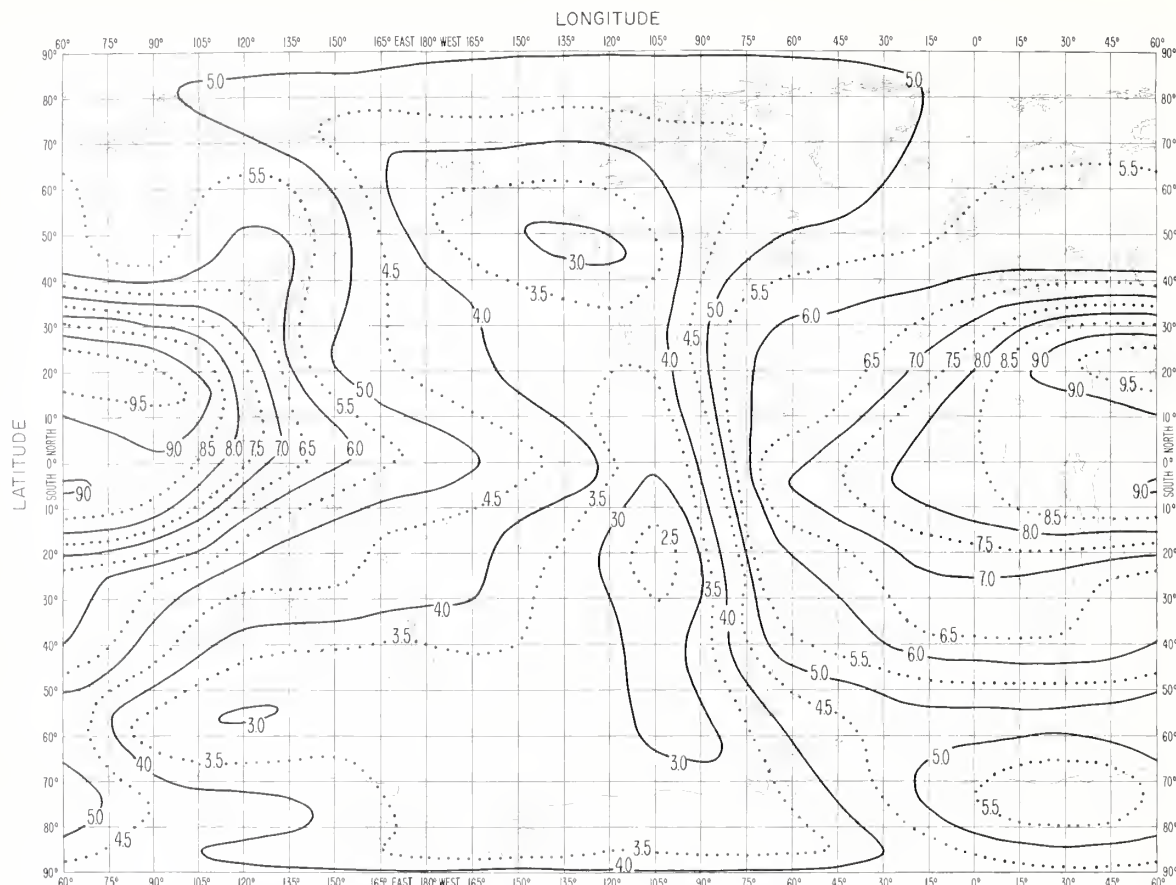


FIG 7A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

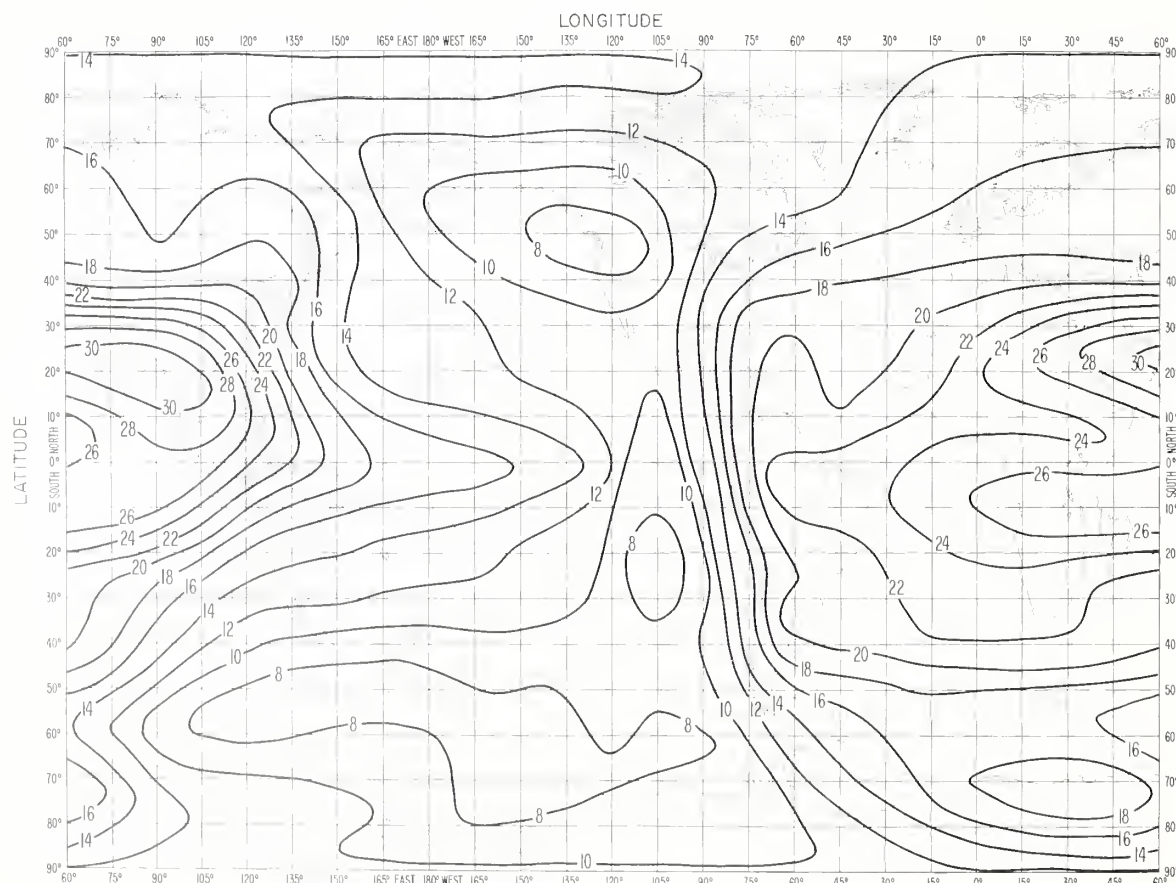


FIG 7B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1963 UT = 14

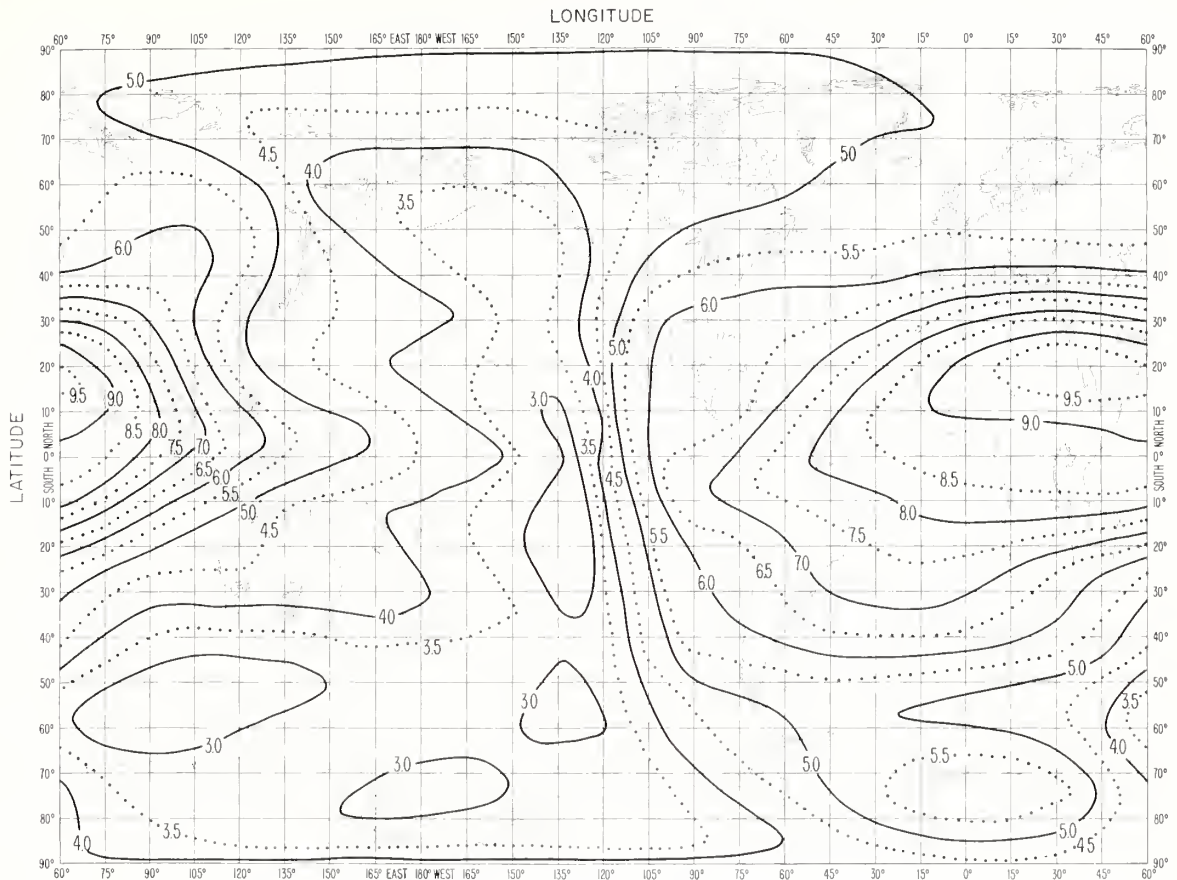


FIG 8A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

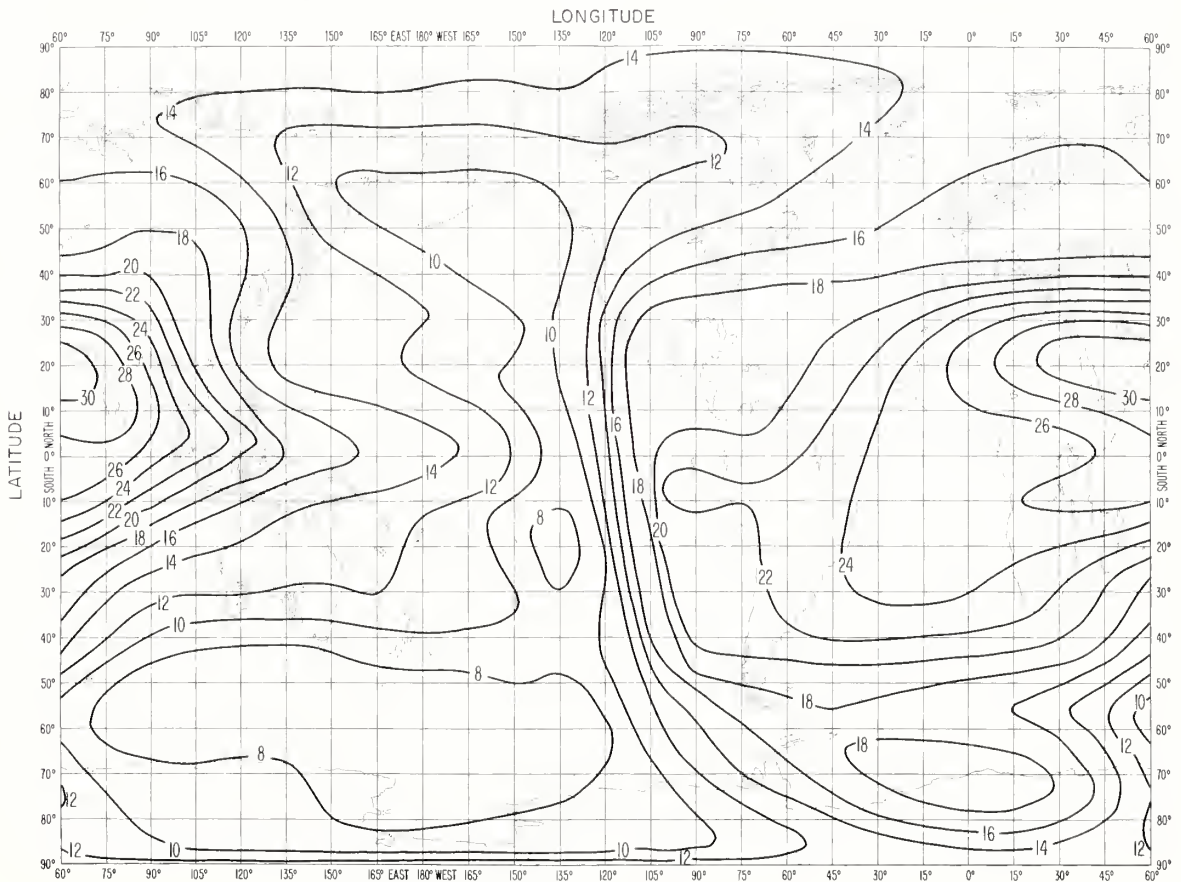
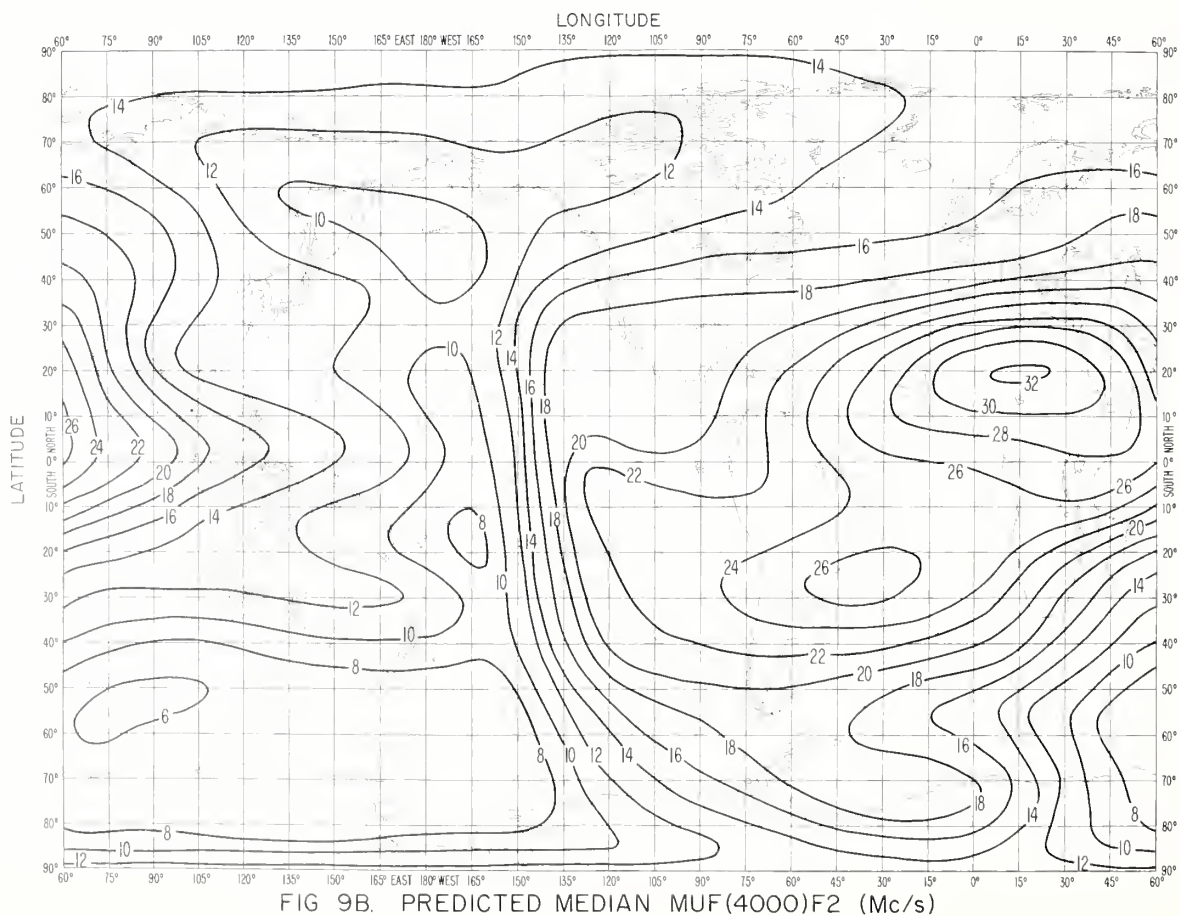
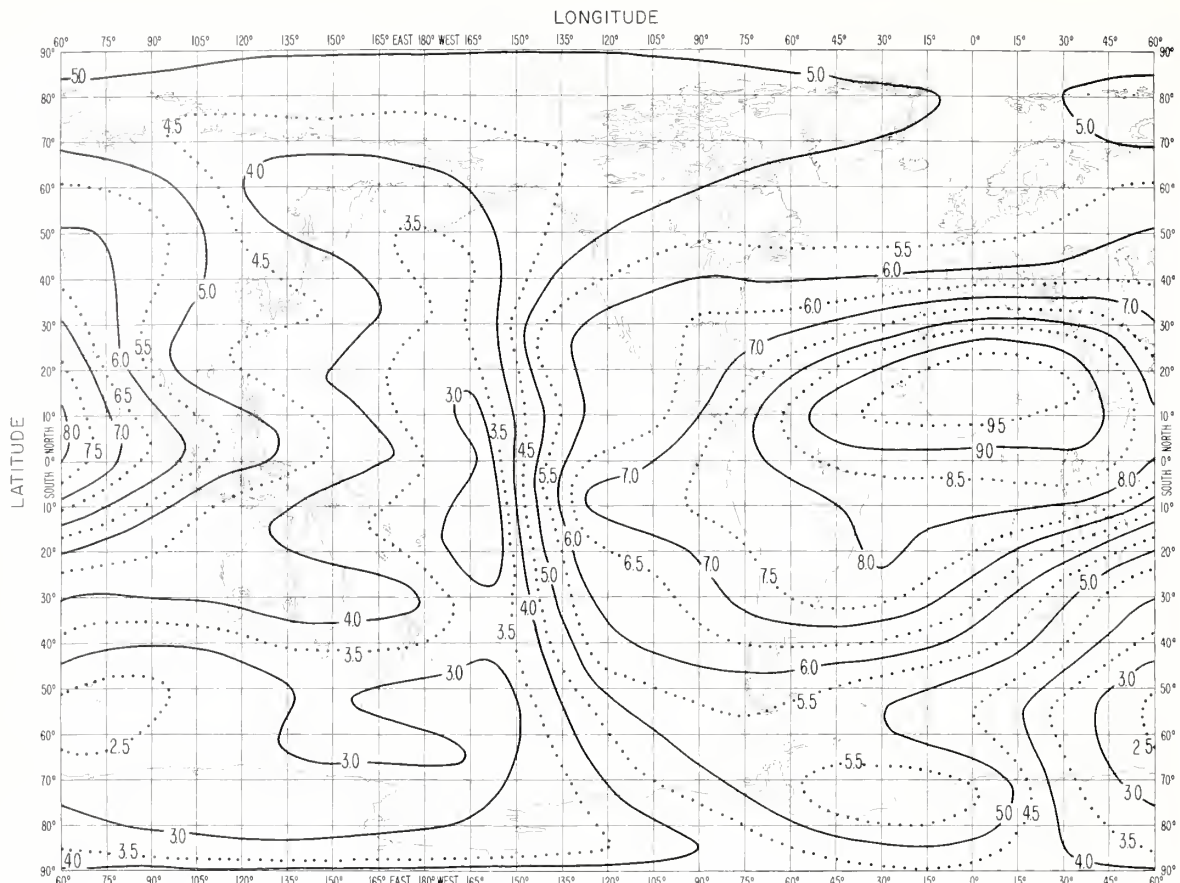


FIG 8B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1963 UT = 16



AUGUST 1963 UT = 18

LONGITUDE

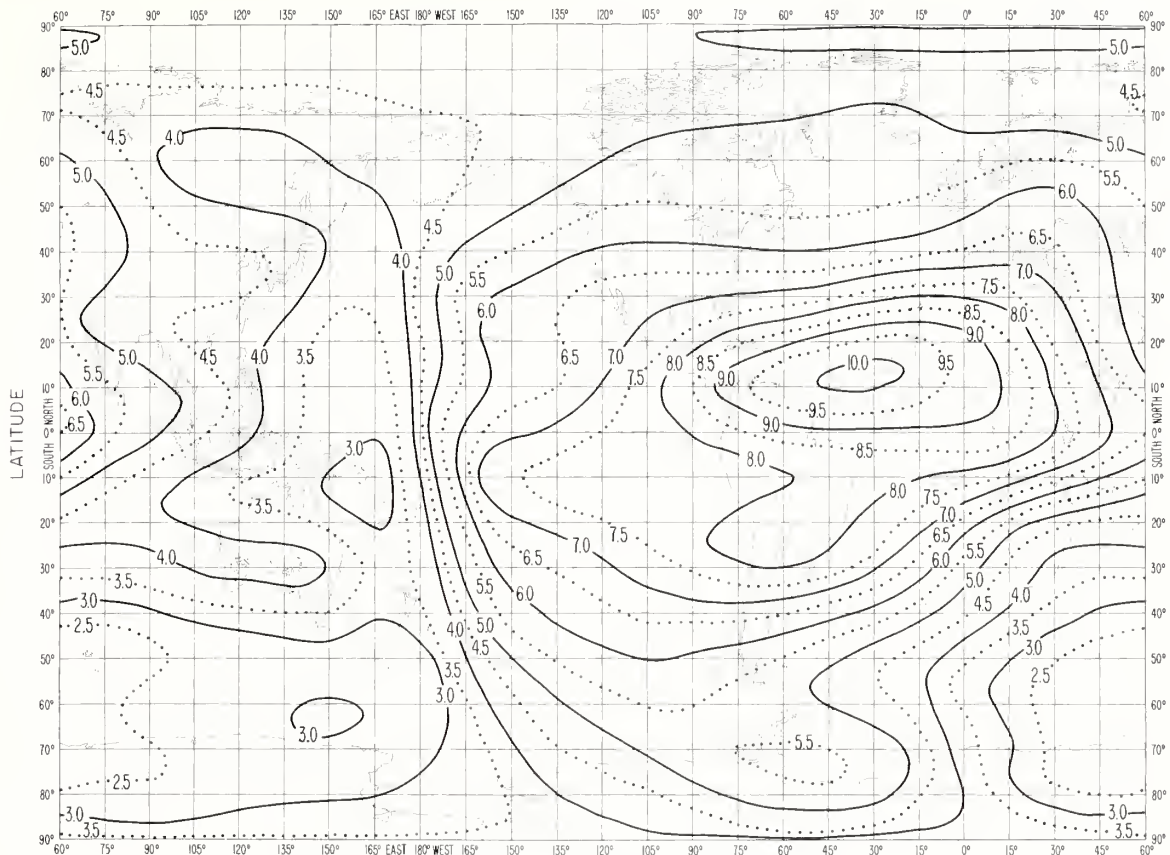


FIG 10A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

LONGITUDE



FIG 10B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1963 UT = 20

LONGITUDE



FIG IIA. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

LONGITUDE

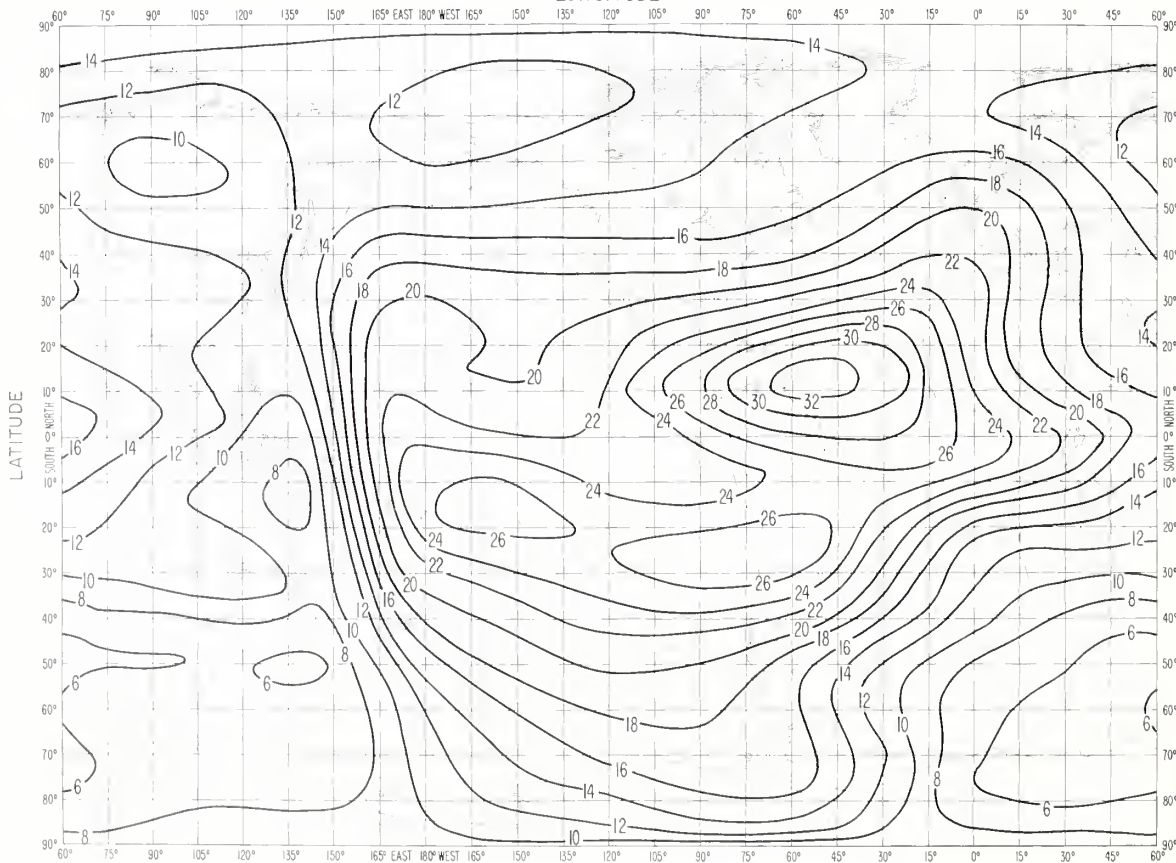


FIG IIB. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

AUGUST 1963 UT = 22

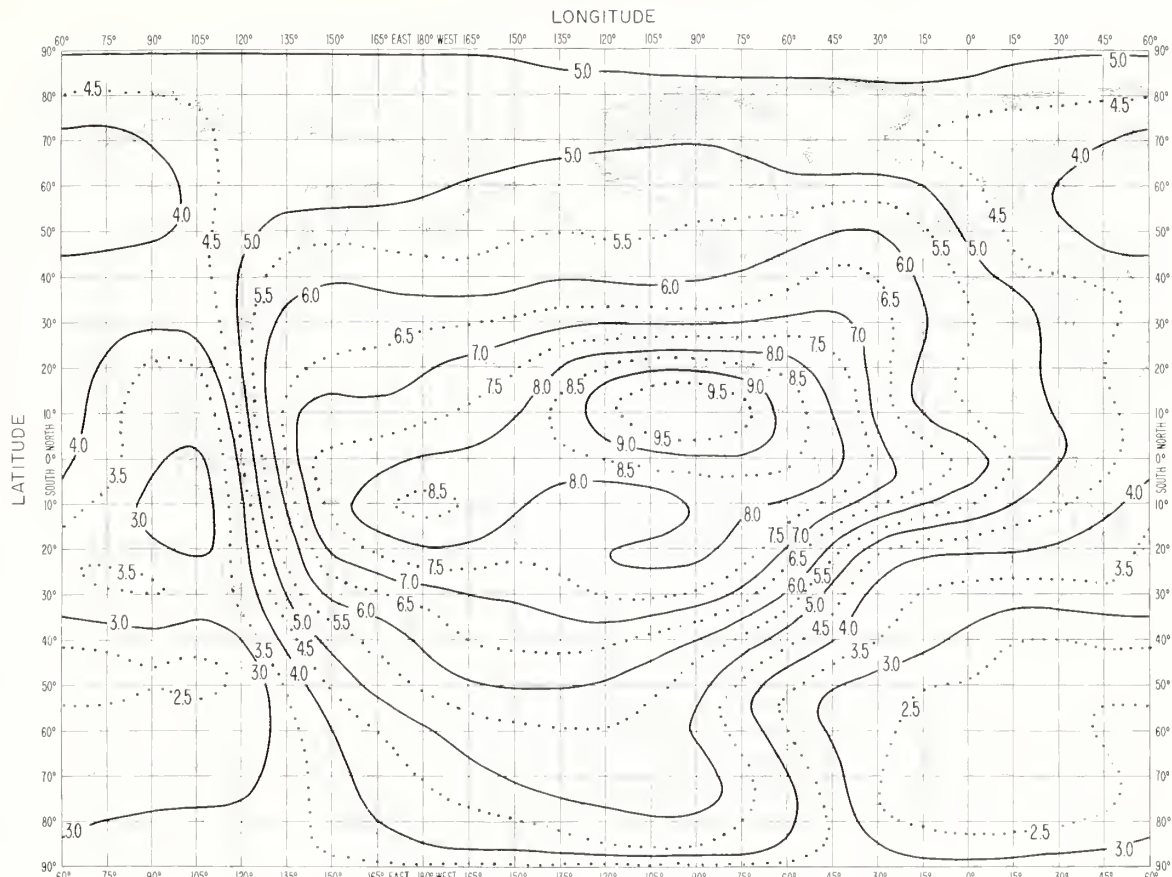


FIG I2A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

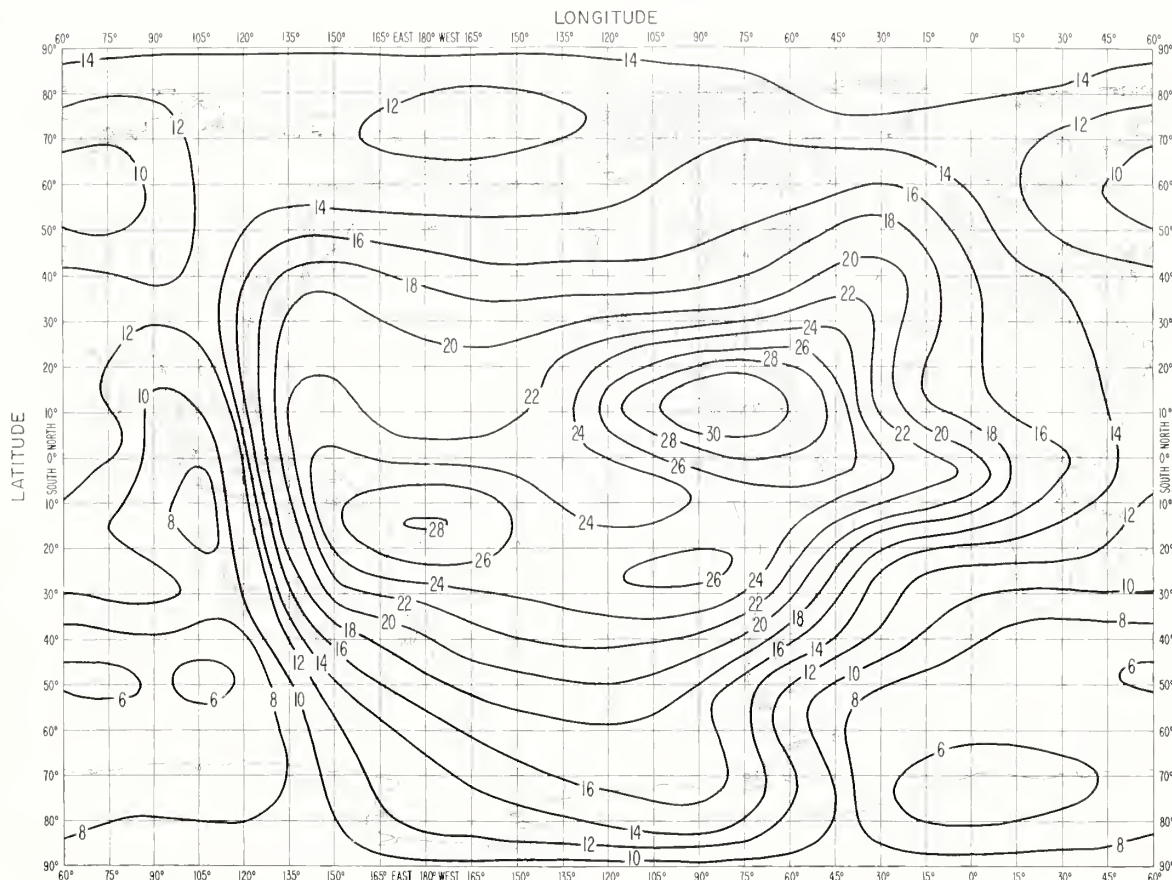


FIG I2B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NORTH POLAR AREA
AUGUST 1963 UT=00

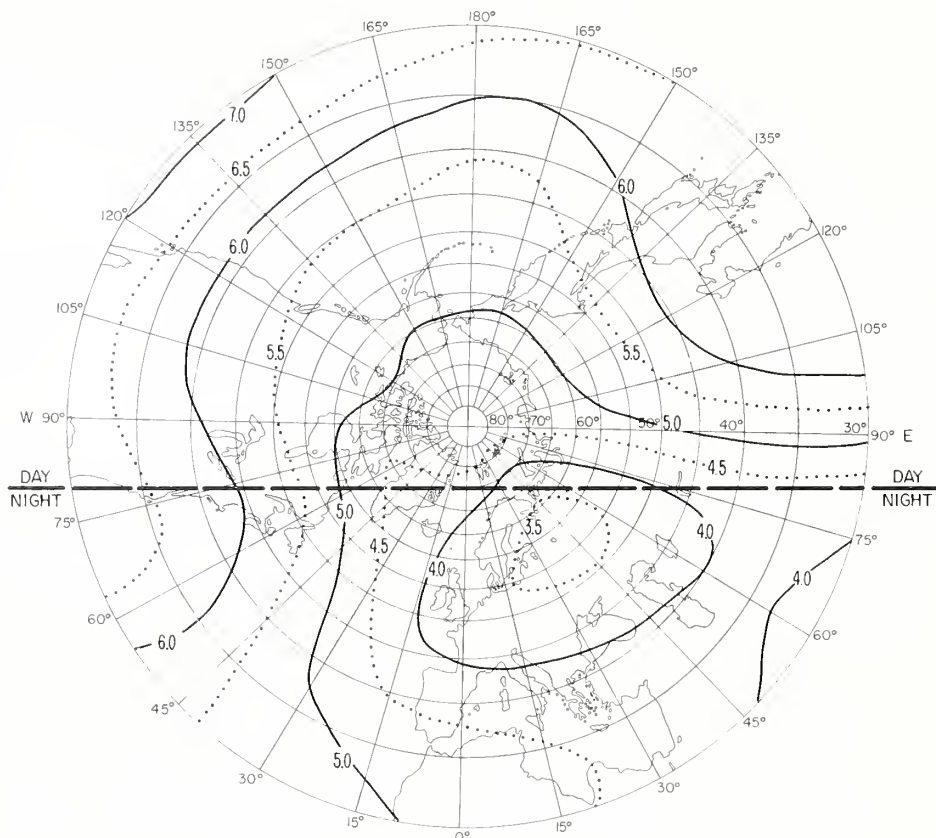


FIG.13A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

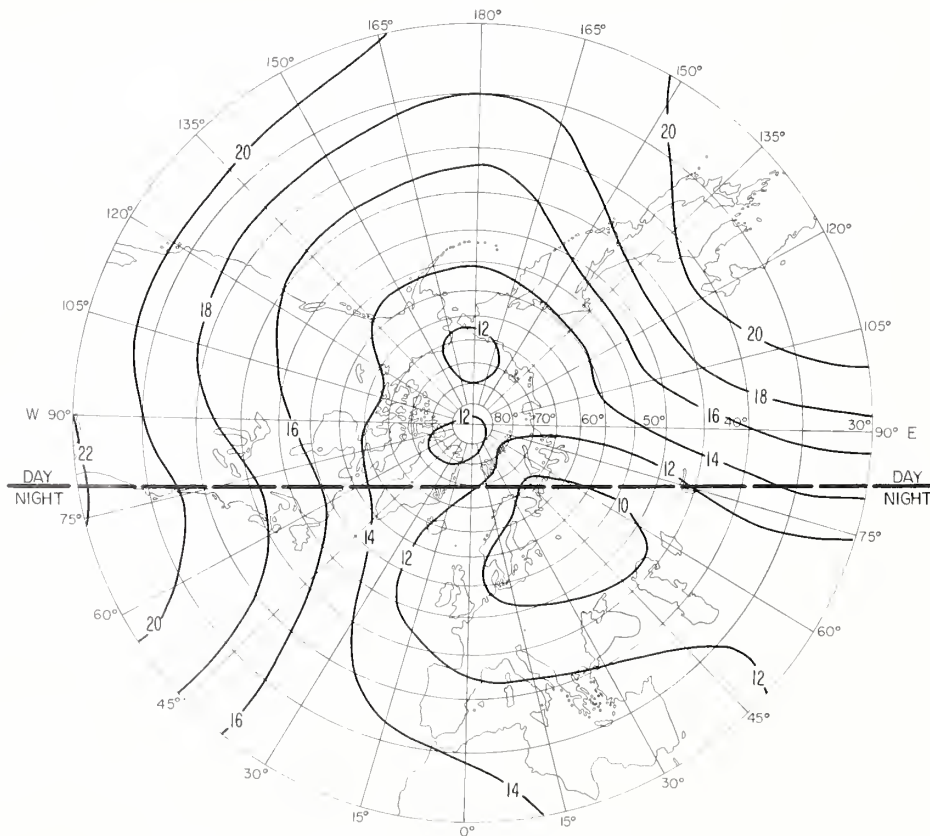


FIG.13B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

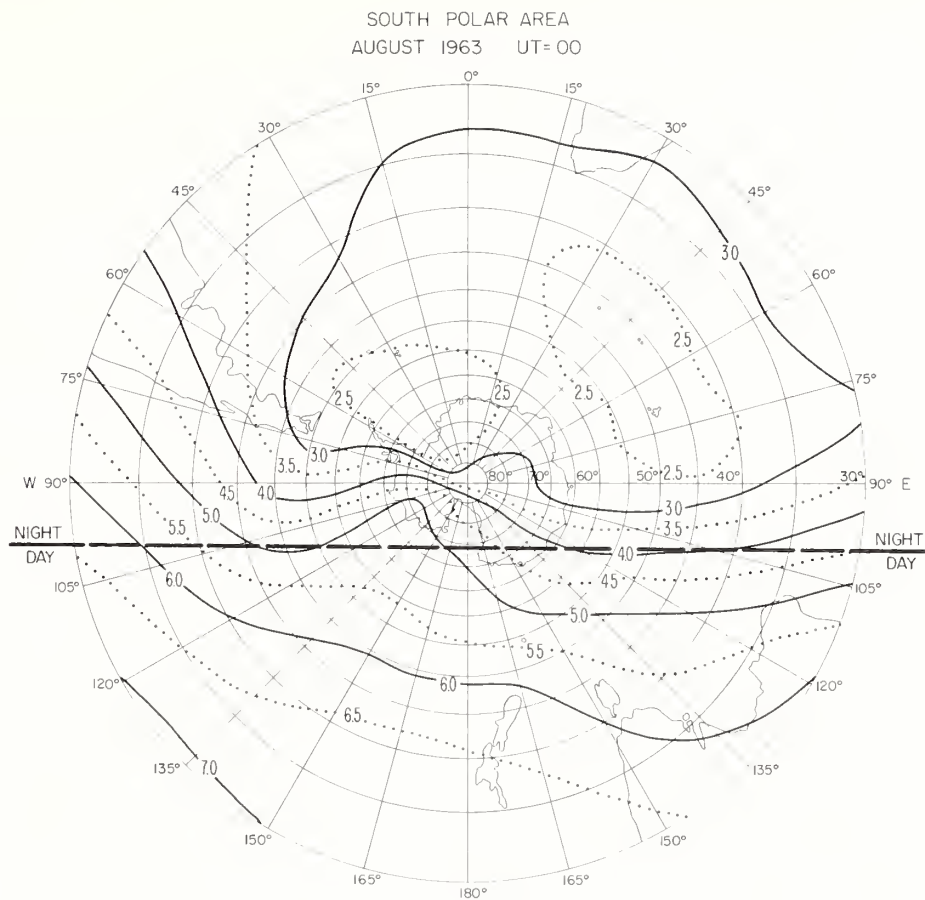


FIG.14A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

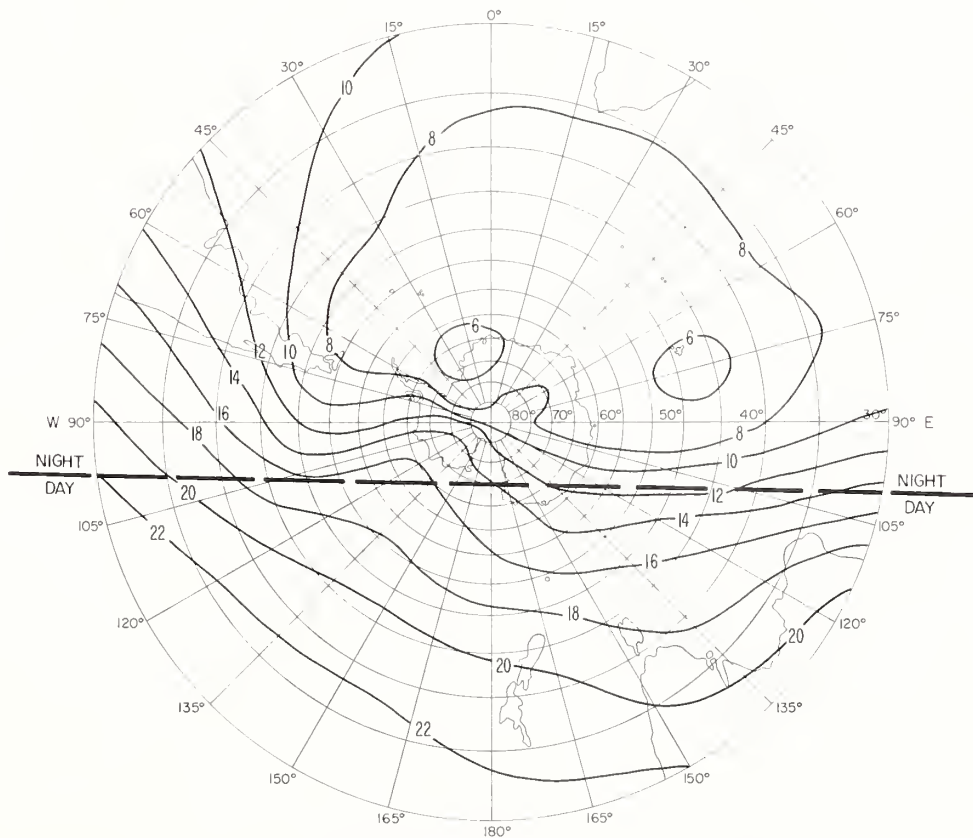


FIG.14B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

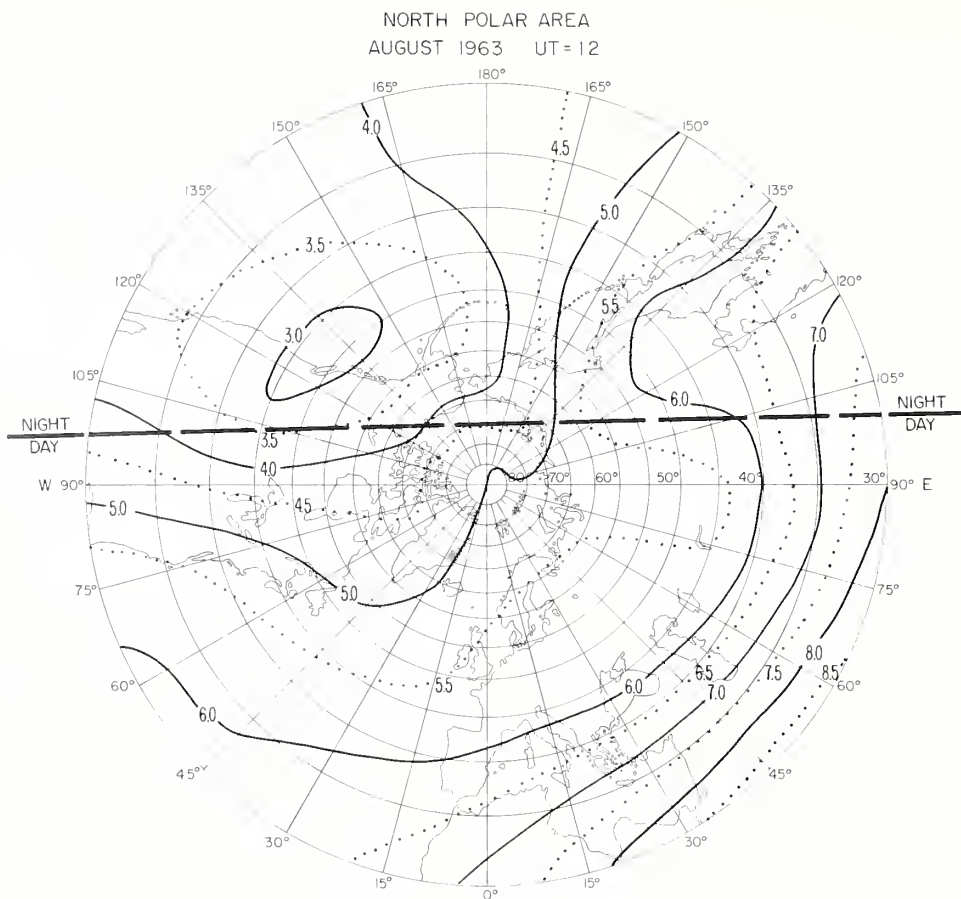


FIG 15A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

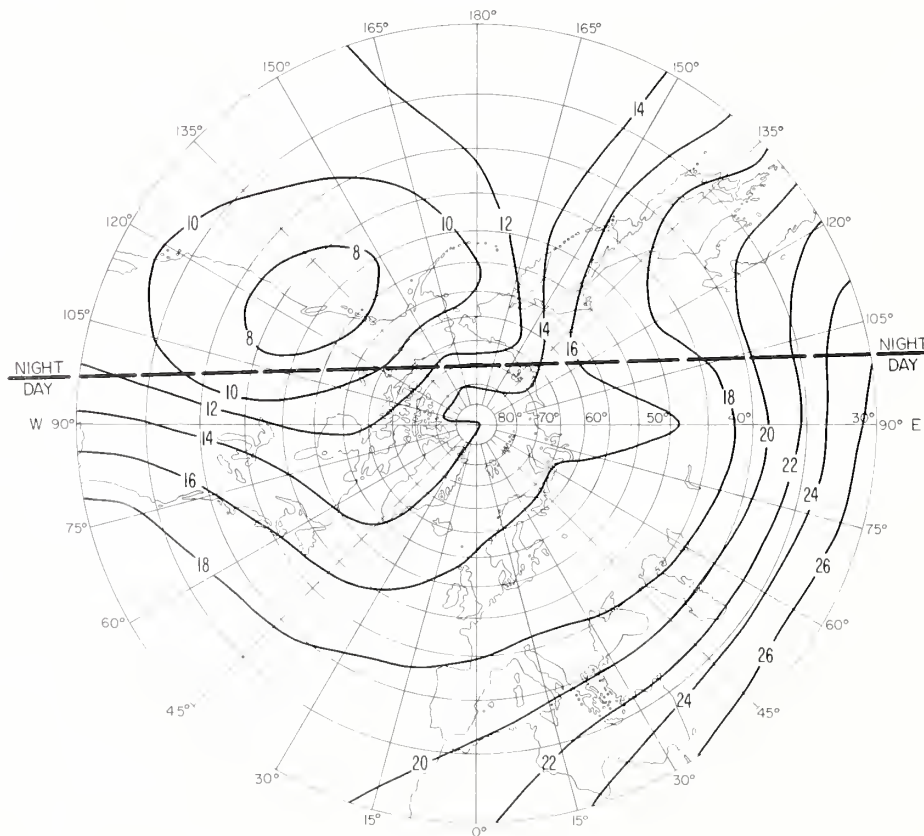


FIG.15B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

SOUTH POLAR AREA
AUGUST 1963 UT=12

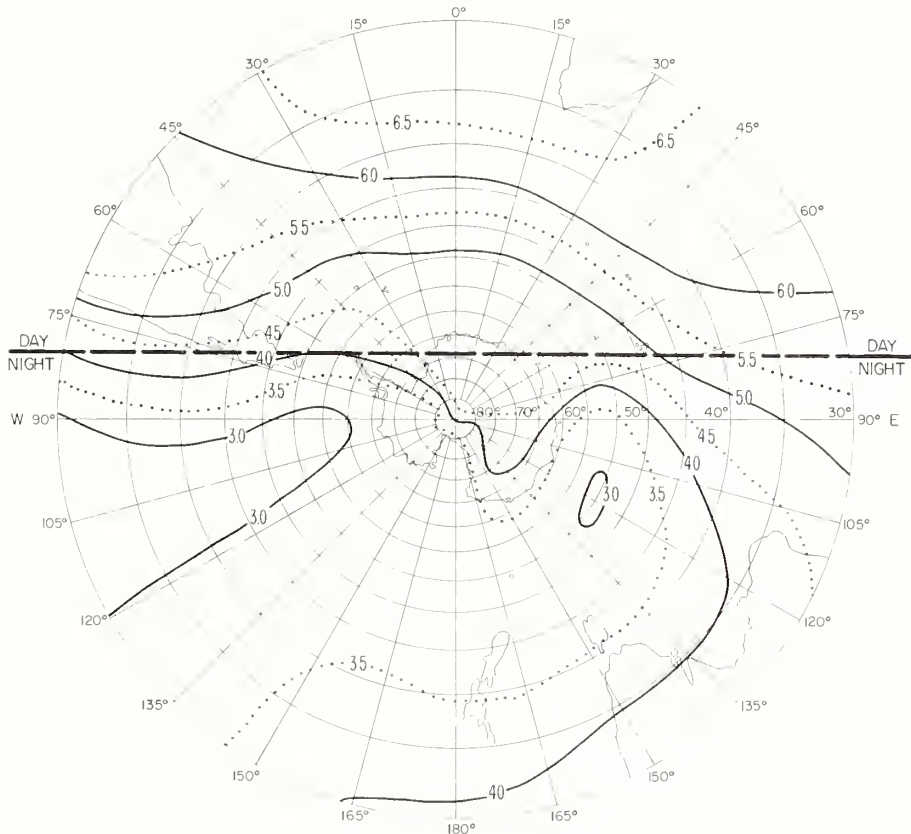


FIG.16A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

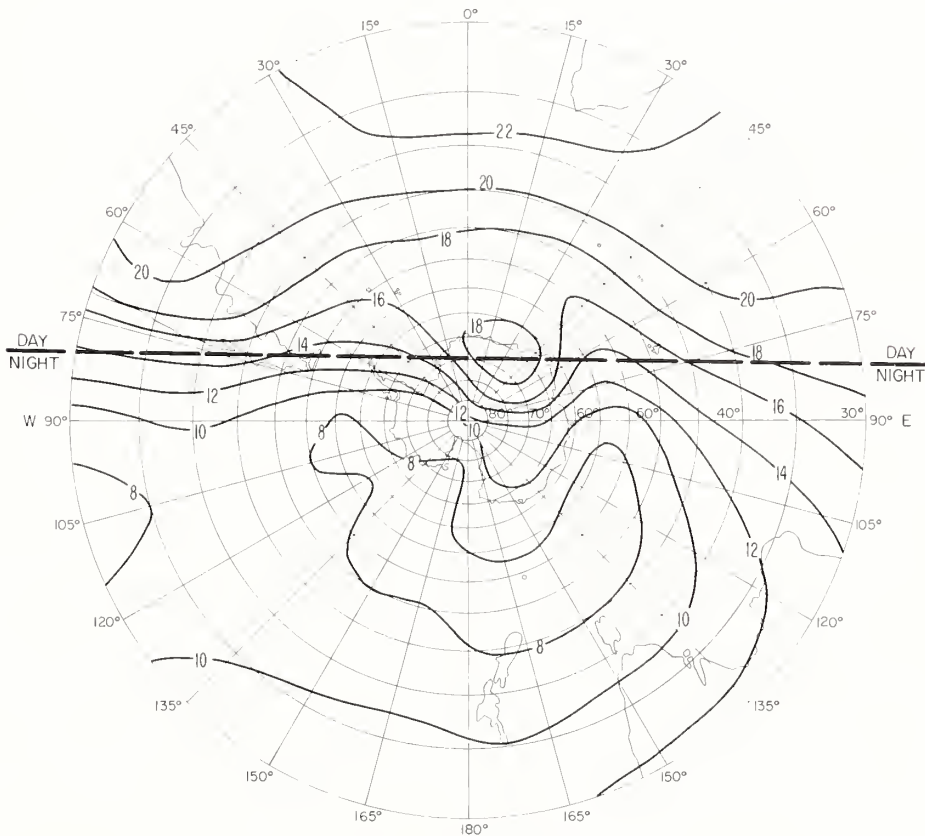


FIG.16B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

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NG: None.

USAR: None.

For explanation of abbreviations used, see AR 320-50.